

**Citation:**

Kerver JM, Yang EJ, Obayashi S, Bianchi L, Song WO. Meal and snack patterns are associated with dietary intake of energy and nutrients in US adults. *J Am Diet Assoc* 2006; 106: 46-53.

**PubMed ID:** [16390666](#)

**Study Design:**

Cross-sectional design

**Class:**

D - [Click here](#) for explanation of classification scheme.

**Research Design and Implementation Rating:**

POSITIVE: See Research Design and Implementation Criteria Checklist below.

**Research Purpose:**

To test the association between meal and snack patterns and nutrient intakes in adults.

**Inclusion Criteria:**

- Participation in the Third National Health and Nutrition Examination Survey (NHANES III), 1988-1994
- Age  $\geq 20$  years
- Complete and reliable 24-hour dietary recall data, as determined by the National Center for Health Statistics (NCHS).

*Consent was not discussed in the article, but NHANES participants provide informed consent per NCHS documentation.*

**Exclusion Criteria:**

- Age less than 20 years
- Incomplete or unreliable 24-hour dietary recall data, as determined by the NCHS.

**Description of Study Protocol:****Recruitment**

The study was a secondary data analysis of NHANES III (1988-1991); specific recruitment procedures were not described.

## **Design**

- NHANES III is a multi-stage probability sample of the non-institutionalized, civilian US population age two months and older
- Older adults, African Americans and Mexican Americans were oversampled to produce more precise estimates for these sub-groups
- Recruited subjects completed a demographic interview, physical examination and face-to-face 24-hour dietary recall
- The study is cross-sectional and subjects were interviewed in either English or Spanish.

## **Dietary Intake/Dietary Assessment Methodology**

The survey used a face-to-face 24-hour recall interview

- Subjects reported all food and beverages, except plain drinking water, consumed midnight to midnight the previous day
- They also estimated amounts consumed and named the eating occasion for each item.

## **Statistical Analysis**

- All analyses accounted for the complex sample design via appropriate weighting and variance estimation
- Subjects with any missing data were excluded via listwise deletion
- Percentages and means were computed
- Categorical associations were assessed with a chi-square test
- Linear regression was conducted to test for associations between eating frequency and meal pattern groups with nutrients as the dependent variable, while controlling for several demographic and behavioral characteristics.

## **Data Collection Summary:**

### **Timing of Measurements**

All data were collected in a single visit.

### **Dependent Variables**

Sociodemographic and behavioral characteristics:

- Sex
- Age:
  - 20-39
  - 40-59
  - 60 years and older

- Ethnicity:
  - Non-Hispanic white
  - Non-Hispanic black
  - Mexican American
- Education:
  - Less than 12
  - 12
  - More than 12 years
- Poverty income ratio: Computed as the ratio between income and the Census Bureau-determined poverty threshold
  - $\leq 1.85$
  - 1.86-3.5
  - More than 3.5
- Smoking status: Smoker, non-smoker
- Alcohol intake:
  - Non-drinker (zero per day)
  - Light (zero to 0.5 drinks per day)
  - Moderate (0.5 to less than two drinks per day)
  - Heavy drinker (more than two drinks per day)
- Vitamin/mineral supplement use: Yes or No
- Activity level: Sum of frequency of leisure time activities multiplied by the estimated oxygen consumption of each activity
  - <33rd
  - 33-66th
  - >66th percentile.

#### Nutrient intakes:

- Energy (kcal)
- Protein (percent energy)
- Carbohydrate (percent energy)
- Total fat (percent energy)
- Cholesterol (mg)
- Vitamin B<sub>6</sub> (mg)
- Folic acid ( $\mu\text{g}$ )
- Vitamin C (mg)
- Calcium (mg)
- Magnesium (mg)
- Iron (mg)
- Sodium (mg)
- Potassium (mg)
- Dietary fiber (g).

#### Independent Variables

- Daily eating frequency (one to two [reference], three, four, five, at least six per day)
- Meal pattern (breakfast included brunch; snacks included both snacks and beverages, per NCHS categories)
  - Breakfast, lunch, dinner plus at least two snacks (BLD2S)
  - Breakfast, lunch, dinner plus one snack (BLDS)
  - Breakfast, dinner plus at least two snacks (BD2S)

- Breakfast, lunch, dinner (BLD)
- Lunch, dinner plus at least snacks (LD2S)
- Other.

### Control Variables

- Sex
- Race/ethnicity
- Smoking status
- Alcohol intake
- Vitamin/mineral supplement use
- Age
- BMI
- Physical activity
- Income
- Energy intake.

### Description of Actual Data Sample:

- *Initial N*: 18,125 NHANES III participants were age-eligible for inclusion
- *Attrition (final N)*: 15,978 (88%) provided valid and reliable dietary recall data (47.4% male)
- *Age*:
  - 46.3% age 20-39 years
  - 31.3% age 40-59 years
  - 22.5% age 60 years or older
- *Ethnicity*:
  - 82.7% non-Hispanic white
  - 11.8% non-Hispanic black
  - 5.5% Mexican American
- *Other relevant demographics*:
  - Education:
    - 24.7% <12 years
    - 33.8% 12 years
    - 41.5% >12 years
  - Poverty income ratio:
    - 30%  $\leq 1.85$
    - 34% 1.86-3.5
    - 36.1% >3.5
  - 28.3% nonsmokers
  - Alcohol intake:
    - 44.5% non-drinker
    - 37% light drinker
    - 9.3% moderate drinker
    - 9.3% heavy drinker
  - 42.3% vitamin/mineral supplement users
  - Activity level:
    - 33.5% <33rd percentile
    - 33.1% 33-66th percentile
    - 33.4% >66th percentile

## Summary of Results:

### Eating frequency

- Subjects reported an average of  $4.9 \pm 0.04$  daily eating occasions (range: zero-18)
- More frequent eaters (at least six times per day) were more likely to be age 40-59 years, white, smokers, heavier drinkers, supplement users, with higher income and education, compared to less frequent eaters (one to two times per day)
- More frequent eaters had higher adjusted intakes of carbohydrate, folic acid, vitamin C, calcium, magnesium, iron, potassium, dietary fiber, lower intakes of dietary fat, protein, cholesterol and sodium than less frequent eaters.

### Snack and meal patterns

- Lunch was the meal skipped most often (26.1%), followed by breakfast (17.7%) and dinner (10.4%). 62% reported at least two snacks per day and 25% had one snack.
- 23 different meal and snack patterns were identified, but three-fourths fit into the five categories reported in the table. Non-Hispanic black and Mexican American subjects were more likely not to fit into one of the five main patterns
- Subjects who ate breakfast, lunch, dinner and at least two snacks (BLD2S), the most frequent pattern, were more likely to be female, age 40-59 years, white, non-smokers, moderate drinkers, supplement users, with higher income and education levels and moderate physical activity
- Non-snackers had the lowest adjusted energy and carbohydrate and highest protein and total fat intakes. Those in the BLD2S pattern had highest energy and carbohydrate and lowest total fat intakes. Those who ate lunch, dinner and at least two snacks had the highest intakes of all micronutrients except cholesterol, vitamin B<sub>6</sub> and sodium, which were consumed in the highest amounts by the breakfast, lunch and dinner group.

	Daily Eating Frequency					
	1-2	3	4	5	At least 6	P-value
<b>Sociodemographic/behavior characteristics (N=15,978)</b>						
<b>Population (percent)</b>	4.2	16.5	25.0	24.3	30.0	
<b>Sex</b>						0.0958
Male	4.8	16.1	24.7	23.5	30.9	
Female	3.7	16.9	25.4	24.8	29.2	
<b>Age group (years)</b>						<0.0001
20-39	5.8	16.4	24.7	23.3	29.8	
40-59	2.7	13.7	21.6	26.5	35.5	
60 and older	3.2	20.5	30.6	22.9	22.8	
<b>Ethnicity</b>						<0.0001

Non-Hispanic white	3.0	14.2	24.0	25.1	33.7	
Non-Hispanic black	10.8	24.9	27.5	19.0	17.9	
Mexican American	8.7	26.9	28.6	19.7	16.1	
<b>Education (years)</b>						<0.0001
<12	6.9	22.5	29.4	21.1	20.2	
12	4.3	16.2	25.1	24.3	30.1	
>12	2.6	13.1	22.4	26.1	35.8	
<b>Poverty income ratio</b>						<0.0001
≤1.85	7.4	21.7	28.9	19.6	22.4	
1.86-3.5	3.6	14.3	24.5	24.9	32.7	
>3.5	2.0	13.3	22.1	27.2	35.4	
<b>Smoking status</b>						0.0001
Smoker	5.2	15.2	22.0	23.7	33.9	
Non-smoker	3.9	17.0	26.3	24.4	28.5	
<b>Alcohol intake</b>						<0.0001
Non-drinker	4.9	18.8	28.2	23.2	25.0	
Light drinker	3.3	15.9	23.7	24.7	32.4	
Moderate drinker	4.8	12.8	19.9	25.9	36.5	
Heavy drinker	3.8	11.9	20.5	25.5	38.4	
<b>Vitamin/mineral supplement use</b>						<0.0001
Yes	2.7	14.4	24.0	26.4	32.5	
No	5.4	18.0	25.8	22.6	28.2	
<b>Activity level (percentile)</b>						0.0973
<33rd	3.6	17.3	24.8	23.8	30.5	
33-66th	4.5	14.5	23.9	25.0	32.1	
>66th	3.2	15.3	24.2	25.8	31.5	
<b>Adjusted nutrient intakes, mean± SE (N=10,893 for eating frequency; N=7,502 for patterns)</b>						
Energy (kcal)	1,446±60	1,910±32	2,140±25	2,288±23	2,540±35	<0.0001
Protein (percent kcal)	16.5±0.5	15.9±0.2	15.5±0.2	15.2±0.2	14.9±0.1	0.0002
Carbohydrate (percent kcal)	44.9±1.0	47.3±0.4	48.8±0.3	49.3±0.4	51.1±0.04	<0.0001
Total fat (percent kcal)	36.7±0.9	34.9±0.3	34.1±0.3	34.3±0.3	32.7±0.3	<0.0001
Cholesterol (mg)	322±17	311±9	294±7	291±7	261±5	0.0001

Vitamin B <sub>6</sub> (mg)	1.86±0.06	1.96±0.03	1.96±0.03	1.89±0.02	1.96±0.02	0.0794
Folic acid (μg)	258±9	286±6	302±7	289±5	302±4	0.0007
Vitamin C (mg)	91.7±5.8	102.5±3.3	109.2±3.3	105.1±3.3	111.3±3.3	0.0222
Calcium (mg)	778±32	851±13	848±17	866±19	887±12	0.0304
Magnesium (mg)	279±5	296±3	306±3	312±3	330±3	<0.0001
Iron (mg)	14.5±0.4	15.3±0.3	16.3±0.4	16.0±0.3	16.4±0.3	0.0014
Sodium (mg)	3,765±105	3,690±47	3,659±43	3,627±34	3,500±27	0.0011
Potassium (mg)	2,751±58	2,850±37	2,916±28	2,944±25	3,088±28	<0.0001
Dietary fiber (g)	15.5±0.4	16.6±0.2	17.2±0.3	17.2±0.3	17.6±0.2	0.0002

### Meal and Snack Patterns

	BLD2S	BLDS	BD2S	BLD	LD2S	Other	P-value
<b>Sociodemographic/behavior characteristics (N=15,978)</b>							
<b>Population (percent)</b>	31.6	15.4	13.1	8.3	7.6	24.1	
<b>Sex</b>							<0.0001
Male	29.4	13.7	14.3	7.8	8.5	26.3	
Female	33.6	16.9	12.0	8.6	6.8	22.2	
<b>Age group (years)</b>							<0.0001
20-39	28.5	13.0	12.5	6.9	9.9	29.3	
40-59	37.2	14.2	14.0	6.9	8.0	19.7	
60 and older	30.2	21.8	13.0	13.0	2.3	19.8	
<b>Ethnicity</b>							<0.0001
Non-Hispanic white	35.7	16.0	13.4	7.9	8.0	19.0	
Non-Hispanic black	16.1	12.1	13.8	8.1	6.5	43.3	
Mexican American	15.3	13.4	8.0	10.7	6.9	45.6	
<b>Education (years)</b>							<0.0001
<12	19.9	16.3	13.6	10.3	5.8	34.2	
12	30.4	15.5	13.4	8.2	8.3	24.1	
>12	39.5	14.8	12.6	7.0	8.1	18.1	
<b>Poverty income ratio</b>							<0.0001
≤1.85	20.3	15.3	12.4	9.3	7.1	35.8	

1.86-3.5	33.8	14.9	14.2	7.7	8.2	21.3	
>3.5	40.3	15.7	12.4	7.5	8.2	16.0	
<b>Smoking status</b>							<0.0001
Smoker	27.8	10.3	15.8	6.3	10.8	28.9	
Non-smoker	33.1	17.4	12.0	9.0	6.3	22.2	
<b>Alcohol intake</b>							<0.0001
Non-drinker	29.9	17.2	11.6	10.1	6.0	24.6	
Light drinker	31.8	14.5	13.7	6.9	9.2	24.0	
Moderate drinker	37.6	10.5	15.9	7.3	8.2	20.6	
Heavy drinker	33.4	11.7	15.2	6.1	8.2	25.3	
<b>Vitamin/mineral supplement use</b>							<0.0001
Yes	36.6	15.8	14.2	8.1	6.4	18.9	
No	27.9	15.1	12.3	8.4	8.5	27.9	
<b>Activity level (percentile)</b>							0.0003
<33rd	31.2	14.7	12.8	9.1	8.4	23.9	
33-66th	34.6	14.5	12.1	6.9	8.6	23.2	
>66th	33.3	15.8	15.3	7.9	6.4	21.4	
<b>Adjusted nutrient intakes, mean± SE (N=10,893 for eating frequency; N=7,502 for patterns)</b>							
Energy (kcal)	2,461±25	2,214±33	2,248±48	2,009±46	2,263±58		<0.0001
Protein (percent kcal)	15.3±0.1	16.0±0.2	14.3±0.2	16.4±0.3	15.4±0.3		<0.0001
Carbohydrate (percent kcal)	50.6±0.4	48.9±0.4	49.3±0.6	47.2±0.5	48.6±0.6		<0.0001
Total fat (percent kcal)	33.4±0.3	34.4±0.4	34.0±0.5	35.0±0.4	34.1±0.5		0.0015
Cholesterol (mg)	269±4	299±9	321±9	323±10	256±8		<0.0001
Vitamin B <sub>6</sub> (mg)	2.07±0.03	2.09±0.09	1.93±0.03	2.10±0.05	1.83±0.04		<0.0001
Folic acid (µg)	322±5	327±10	299±6	314±10	252±7		<0.0001
Vitamin C (mg)	116±3	117±4	111±4	112±5	98±4		0.0055
Calcium (mg)	942±14	921±27	848±16	923±18	818±27		<0.0001



Magnesium (mg)	339±3	327±4	320±5	312±4	310±6		<0.0001
Iron (mg)	17.5±0.3	17.6±0.5	16.0±0.4	16.7±0.4	14.5±0.3		<0.0001
Sodium (mg)	3,685±29	3,889±53	3,536±56	3,946±48	3,810±67		<0.0001
Potassium (mg)	3,177±23	3,112±36	3,026±42	3,025±41	2,995±67		0.0001
Dietary fiber (g)	18.6±0.2	18.6±0.4	16.9±0.4	17.4±0.4	16.8±0.4		<0.0001

### Author Conclusion:

- This nationally representative study provided descriptive information on the associations between meal and snack patterns and nutrient intakes. Increasing eating frequency was associated with higher energy and carbohydrate and lower fat and protein intakes. This may be due to snacks being carbohydrate-rich and having low nutrient density
- Meal and snack patterns, rather than just eating frequency, may be markers for macro- and micronutrient intake and overall diet quality
- Although the no snacking groups and the BLD2S group had significantly different energy and macronutrient intakes, the absolute differences were small. However, micronutrient differences were large. Breakfast skippers had the highest intakes except for sodium, suggesting the meal provides significant daily nutrients, an observation that is in accordance with the literature
- Differences in researcher and respondent definitions, both within and across studies, make direct comparisons between the findings and the literature difficult.

### Reviewer Comments:

- *Author-identified limitations:*
  - *The meal and snack classification was limited to definitions in NHANES III, which combined snacks and beverages into a single category*
  - *The cross-sectional design did not allow for any cause-and-effect analyses*
- *Results were limited to subjects without missing data. It is possible that item non-response might bias the estimates and limit generalizability, and the authors did not describe whether non-response was related to either eating frequency or meal and snack patterns*
- *The article has a discrepancy in meal pattern names. The methods section includes a breakfast, dinner plus two snacks pattern (BD2S), which is also included in Table 4 on meal/snack patterns and nutrient intakes and the results section. This pattern is not in Table 3 for meal and snack patterns and sociodemographic and behavioral characteristics. Instead, it appears to be listed as breakfast, lunch plus two snacks (BL2S) although its prevalence is identical to the one in Table 4. I believe it should be BD2S and have labeled it as such for this abstract*

### Research Design and Implementation Criteria Checklist: Primary Research

## Relevance Questions

- |    |   |     |
|----|---|-----|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | Yes |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?   | Yes |
| 3. | Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?  | Yes |
| 4. | Is the intervention or procedure feasible? (NA for some epidemiological studies)  | Yes |

## Validity Questions

- |      |   |     |
|------|---|-----|
| 1.   | <b>Was the research question clearly stated?</b>  | Yes |
| 1.1. | Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?   | Yes |
| 1.2. | Was (were) the outcome(s) [dependent variable(s)] clearly indicated?  | Yes |
| 1.3. | Were the target population and setting specified?   | Yes |
| 2.   | <b>Was the selection of study subjects/patients free from bias?</b>   | Yes |
| 2.1. | Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study? | Yes |
| 2.2. | Were criteria applied equally to all study groups?  | Yes |
| 2.3. | Were health, demographics, and other characteristics of subjects described?   | Yes |
| 2.4. | Were the subjects/patients a representative sample of the relevant population?  | Yes |
| 3.   | <b>Were study groups comparable?</b>  | Yes |
| 3.1. | Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)   | Yes |
| 3.2. | Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?  | Yes |
| 3.3. | Were concurrent controls used? (Concurrent preferred over historical controls.)   | N/A |

3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
<b>4.</b>	<b>Was method of handling withdrawals described?</b>	Yes
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	No
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
<b>5.</b>	<b>Was blinding used to prevent introduction of bias?</b>	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
<b>6.</b>	<b>Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?</b>	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes

6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
<b>7.</b>	<b>Were outcomes clearly defined and the measurements valid and reliable?</b>	<b>Yes</b>
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	N/A
7.7.	Were the measurements conducted consistently across groups?	Yes
<b>8.</b>	<b>Was the statistical analysis appropriate for the study design and type of outcome indicators?</b>	<b>Yes</b>
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes

8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
<b>9.</b>	<b>Are conclusions supported by results with biases and limitations taken into consideration?</b>	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
<b>10.</b>	<b>Is bias due to study's funding or sponsorship unlikely?</b>	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes